Behavioral Adaptations of Cryptic Moths. V. Preliminary Studies on an Anthophilous Species, *Schinia florida* (Noctuidae)

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Abstract: Experiments were conducted on an anthophilous noctuid, *Schinia florida* (Guenée), which rests by day in blossoms of the evening primrose, *Oenothera biennis* L. These experiments involved presenting *S. florida* with choices of various plants to rest upon in a simple experimental apparatus. The results indicated that *S. florida* is able to recognize the primrose plant by olfactory cues, and that the attractive emanation is effectively restricted to the blossoms of this plant. No evidence for an attraction of *S. florida* to yellow substrates was found, but indirect evidence suggested that reflectance characteristics may play a role in attracting these moths to primrose blossoms. It is postulated that the attractive emanation from primrose blossoms may trigger the eclosion of adult *S. florida* in nature.

The primrose moth, *Schinia* (= *Rhodophora*) *florida* (Guenée), is an anthophilous species which rests by day in the flowers of its food plant, the evening primrose (*Oenothera biennis* L.). At first glance, this pink and yellow moth might seem to be warningly colored, but observation of its habits in nature reveal its cryptic adaptations. The moth ordinarily rests folded-up and head-down in a primrose blossom (Fig. 1). In this position, the yellow tips of the moth's fore wings resemble the petals of the blossom, particularly when the blossom partially closes. The pink portion of the moth's fore wings closely matches the color of dying primrose blossoms, and so the moth is easily overlooked, even when resting in an open blossom, or among the blossoms, on the head of this plant.

Further evidence for the cryptic, rather than aposematic, nature of the primrose moth's coloration has been obtained using two caged Pekin robins, *Liothrix lutea* (Scopoli). These birds readily and repeatedly ate *S. florida*, but rejected *Anisota rubicunda* Fabricius (Citheroniidae), which displays similar colors, after one trial. The earlier "experiments" of Jones (1932, 1934), showing a relatively low acceptability of *S. florida* to wild birds, cannot be taken as evidence for any unpalatability of this moth. His results can be equally well interpreted in terms of predator avoidance of novel insects, or generalization from prior experiences with a distasteful species, perhaps *A. rubicunda*.

Descriptions of the life history stages of *S. florida*, and observations regarding the anthophilous habits of the adults, have been contributed by several

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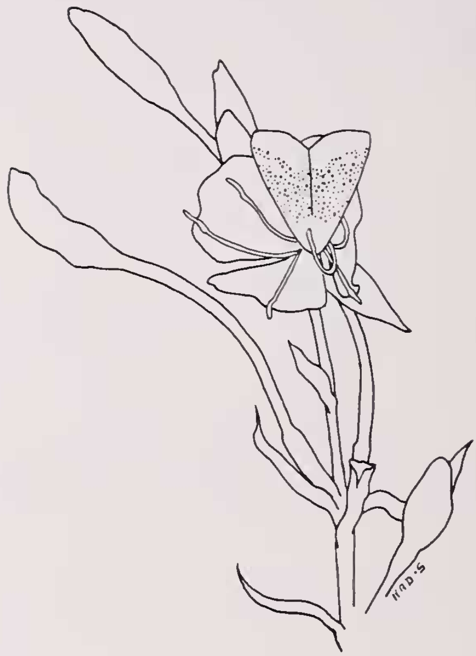

Fig. 1. The typical resting attitude of *S. florida* in a blossom of the evening primrose. Shaded portions of the moth are pink, and unshaded portions are yellow. Life size.

authors (e.g., Fitch, 1867; Saunders, 1869, 1871; Hardwick, 1958, 1967). The only prior behavioral study of a heliothidine moth, to my knowledge, is that of Brower and Brower (1956) on the resting attitudes of *Schinia* (= *Rhododipsa*) *masoni* (Smith) on blossoms of the composite *Gaillardia aristata* Pursh.

The present paper summarizes several preliminary experiments which were designed to shed light on the nature of the attraction of *S. florida* to primrose blossoms.

MATERIALS AND METHODS

Individuals of *S. florida* were collected from primrose blossoms in central Massachusetts (Franklin and Hampshire counties) during the summers of 1967 and 1968. These moths were then tested for plant preferences in a very simple experimental apparatus.

A plywood box (15 inches square by 19 inches high), containing four 12-ounce beer bottles which served as vases for cuttings of various plants, constituted the basic apparatus. The plant cuttings were taken daily in the local area, they were trimmed to approximately 14 inches in height, and they were placed into the bottles; two stalks of one plant species to each bottle. The

EXPT.	PLANTS & SELECTIONS OF THE MOTHS				P
1.	BLOSSOMING STALKS				
	Evening Primrose	St. Johnswort	Goldenrod	Mullein	
	20	5	7	2	★★★
2.	BLOSSOMING STALKS, CLOTH-COVERED				
	Evening Primrose	St. Johnswort	Goldenrod	Mullein	
	15	2	5	7	★★
3.	STALKS, BUDS & BLOSSOMS REMOVED				
	Evening Primrose	St. Johnswort	Goldenrod	Mullein	
	10	9	4	5	ns
4.	BLOSSOMING STALKS				
	Goldenrod	Joe-pyeweed	Queen-Annes-lace	Yarrow	
	13	5	7	7	ns
5.	BLOSSOMING STALKS, PRIMROSE SCENT				
	Goldenrod	Joe-pyeweed	Queen-Annes-lace	Yarrow	
	8	5	9	3	ns

FIG. 2. A summary of the experiments with *S. florida,* showing the numbers of moths selecting the various plants in each experiment. Chi-square tests gave probabilities (P) of less than 0.001 (three stars), less than 0.01 (two stars), and greater than 0.05 (ns = not significant).

experimental box was covered with a pane of window glass, and it was set out in a wooded area. Moths were introduced into the box at night by sliding the glass top to one side, and the selections of the moths (i.e., the plants on which they were resting) were noted on the following morning.

Five experiments were carried out over a series of nights, using from two to ten moths in the experimental box per night. Each moth was used only once in any particular experiment. The data in all of these experiments were analyzed by chi-square tests (goodness-of-fit of the moths' observed distributions to random distributions on the plants).

EXPERIMENTS AND RESULTS

Five experiments, each involving choices among four plants, were conducted with *S. florida*. The data from these experiments are summarized in Fig. 2.

EXPERIMENT 1. The apparatus was initially tested by presenting *S. florida* with a choice among evening primrose (*Oenothera biennis* L.) and three other plants having yellow blossoms, St. John's-wort (*Hypericum perforatum* L.), goldenrod (*Solidago* sp.), and mullein (*Verbascum thapsus* L.). In this case, the distribution of resting moths on the plants differed significantly from random, there being an obvious perference for primrose. This result indicated that the experimental apparatus was suitable for testing the moths' abilities to discriminate among various plants.

EXPERIMENT 2. In order to determine whether *S. florida* could locate primrose without visual or tactile clues to its identity, Experiment 1 was repeated, but now each plant was loosely wrapped in a double layer of cheesecloth. The distribution of moths on the plants again differed significantly from random, and again primrose was obviously preferred. This result indicates that *S. florida* is able to locate primrose on the basis of olfactory stimuli.

EXPERIMENT 3. Since *S. florida* is almost invariably found in or near the blossoms of primrose in nature, the moths were presented with a choice among the four plants previously used, but all buds and blossoms were removed from the experimental cuttings. In this case, the distribution of moths on the plants did not differ from random. This result, in view of the previous evidence for the moths' olfactory recognition of primrose, suggests that an attractive emanation is effectively restricted to the blossoms of this plant.

EXPERIMENT 4. In order to determine whether *S. florida* would exhibit a preference for another yellow flower, should primrose be unavailable, the moths were given a choice among goldenrod, *Solidago* sp., (yellow); joe-pye-weed, *Eupatorium* sp., (pink); queen-Anne's-lace, *Daucus carota* L., (white); and yarrow, *Achillea ptarmica* L., (white). The distribution of moths on these plants did not differ from random.

EXPERIMENT 5. It might be argued that *S. florida* would not seek yellow blossoms unless exposed to the attractive emanation from primrose. Accordingly, Experiment 4 was repeated, but a blossoming head of primrose was wrapped in cheesecloth and placed on the bottom of the experimental box. The distribution of moths on the plants again did not differ from random. In addition to the 25 moths recorded in Fig. 2, nine moths were found resting on the cloth-covered primrose on the bottom of the box. The results of Experiments 4 and 5 suggest that *S. florida* is not attracted to yellow blossoms as such when seeking a resting place.

DISCUSSION

The experiments reported here indicate that the attraction of *S. florida* to evening primrose is based on olfactory stimuli emanating from primrose blossoms. The data also suggest that *S. florida* is not attracted by yellow stimuli when seeking a resting place.

Further evidence for the ineffectiveness of yellow substrates in attracting *S. florida* has been obtained in another experiment. In an apparatus allowing a choice of a yellow background among several gray backgrounds, described in detail in Sargent and Keiper, (1969), none of 11 *S. florida* selected the yellow background. Some evidence suggests, however, that this moth is attracted to substrates of high reflectance. In an apparatus allowing a choice between black and white backgrounds, described in detail in Sargent, (1968), 11 out of 14 *S. florida* selected the white backgrounds. This result suggests that reflectance characteristics may interact with olfactory characteristics to bring *S. florida* to the blossoms of primrose plants.

The apparent restriction of an attractive emanation to the blossoms of evening primrose tempts one to postulate that this emanation may actually trigger the eclosion of adult *S. florida* in nature. At any rate, it is certainly true that *S. florida* is only cryptic on blossoming primrose plants.

Several factors that undoubtedly influence the anthophilous habits of *S. florida* were not investigated in the present study, and these should provide opportunities for further work. One such factor is the apparent tendency of these moths to seek out the apical portions of plant stalks when coming to rest. In addition, the role of tactile stimuli in determining the moths' final resting positions in primrose blossoms would seem particularly amenable to experimental analysis.

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